# Graphene based FET

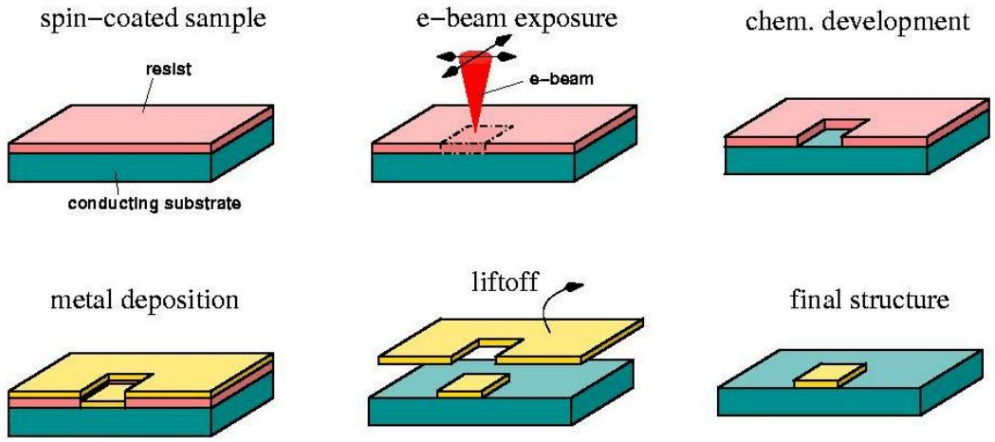
## I. Fabrication

### Scanning Photocurrent Microscopy "SPCM"

- Photoconductivity is an optical and electrical phenomenon in which a material becomes more electrically conductive due to the absorption of electromagnetic radiation such as visible light.
- In a SPCM, a limited laser spot is scanned at the surface of an electronic device, while the photocurrent is recorded as a function of illumination position. This technique has recently been used to characterize, carbon nanotubes, and graphene.

### Electron Beam Lithography "EBL"

- The basic principle of EBL is very similar with conventional photolithography.
- The e-beam resist which is sensitive to electrons is firstly spin coated on a pre-cleaned substrate.
- Resists as poly methyl methacrylate (PMMA) consist of macromolecules that are modified upon exposure to high energy electrons, resulting in a changed solubility.
- A focused beam of electron is scanned across the sample for exposure.
- After exposure, developing will remove the corresponding exposure region where the local resist becomes soluble (for positive resist).
- A lift-off process removes the resist mask and excess material on top of it to obtain the final desired applicable pattern / devices.

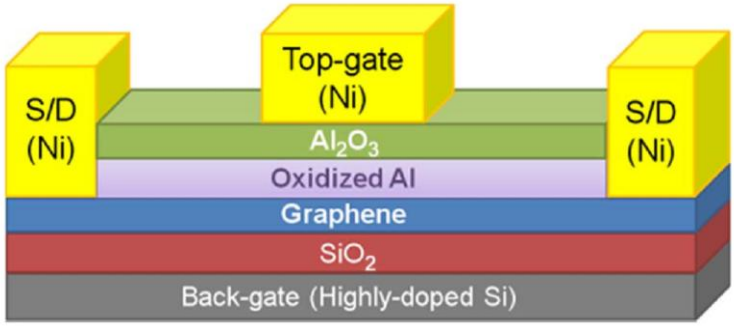



### Mobility Degradation

- Suspended graphene films possess very high carrier mobility, indicating the important role of substrates and gate dielectrics in causing mobility degradation.
- The impact of a top dielectric on the transport characteristics of graphene represents a key issue for graphene-based high-performance FETs.

**Fabrication Process**

- The graphene single-layer sheet is prepared by CVD.
- Graphene is transferred onto highly doped Si substrates covered with thermally grown $SiO_2$.
- Put metal contacts on the samples using e-beam lithography (EBL).
- A thin Al oxide is deposited.
- Deposit 15-nm-thick $Al_2O_3$ film.
- Put Ni top-gate electrode by e-beam lithography (EBL).




## II. Band Gap

- Absence of band gap makes it hard to turn the device off.

**Solution:**

- **Create Band Gap**
  - Armchair (Horizontal Ribbon).
  - Zigzag (Vertical Ribbon).
- **Beyond CMOS IDEAS**
  - BiSFET
  - TFET

## III. Conclusion

- Large-area graphene has been synthesized on metal substrates.
- Dual-gated GFETs and successfully deposited high-k dielectrics such as $Al_2O_3$ which does not substantially degrade the electrical properties of the graphene device.
- GFETs show high leakage current due to graphene being gapless.
- GFETs needs an adequate Band gap to be created using Nano pattering.
- Graphene is not good as a silicon replacement in MOSFETs, but in beyond CMOS technology.